Hydrogen migration through porous media: An experimental comparative study in cap and reservoir rocks

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The renewed interest for dihydrogen underground storage in natural environments has made storage safety an important issue. Since, due to the small size of the molecule, H_2 diffuses faster than most other gaseous species through a porous medium, gas leaks may occur preferentially in some subsurface geological formations. To acquire more data on the impermeability of various lithologies to hydrogen, migration experiments were conducted at ambient temperature in a diffusion cell containing two reservoirs, filled with opposing fluxes of gas (Hydrogen and Nitrogen), and separated by a water-saturated porous sample of rock. Three cores from clay, carbonate, and evaporitic formations were used, with similar porosities (25-30%) but different permeabilities. The mobility of hydrogen through these porous media was measured using gas chromatography. Trace amounts of nobles gases, with various solubilities, were also injected with the hydrogen to serve as a comparative basis for potential retainment in the pore network.

A 1-D numerical model was used to determine the effective diffusion coefficients of H_2 and noble gases within the samples, and compare them to their values in water. Preliminary results show that hydrogen migration in all tested porous media is slowed down more effectively (by at least one order of magnitude) than for noble gases, indicating potential surface adsorption/reaction within the pore network, especially on clay formation samples. The impact of H_2 circulation on minerals potentially affected by a change of redox conditions (such as gypsum, calcite or Fe-rich clay minerals) and present within the targeted saturated porous formation(s), will be discussed.